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THE CONNECTICUT SPECIES OF GYMNOSPORANGIUM (CEDAR APPLES).

R. THAXTER

COMMONWEALTH MYCOLOGICAL INSTITUTE
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THE CONNECTICUT SPECIES OF GYMNOSPORANGIUM (CEDAR APPLES).

By Roland Thaxter, Mycologist.

So much has been written in popular and scientific literature concerning the so-called Cedar Apples and their connection with the production of certain rusts on fruit trees and elsewhere, that it is unnecessary here to give more than a general statement of the facts which should by this time be familiar to agriculturalists generally or at least to fruit growers who are directly interested in the matter. The general facts referred to are as follows. Towards the end of spring, usually in early May, and during rainy weather, the fungus which produces the well-known distortions (cedar apples) just mentioned, protrudes from them in the form of orange-colored gelatinous masses, the orange color being chiefly due to vast numbers of fungus spores formed on the surface of these masses, and known as *teleutospores.* These teleutospores germinate rapidly, without becoming detached from the swollen masses, and give rise each to a number, sometimes as many as a dozen, small secondary spores which are discharged into the air from the sides of short threads protruding from them at various points. These secondary spores (*sporidia*) falling into the air are blown to apple or quince trees or some other plant of the same family, and adhering to the surface of the tender leaves or shoots germinate in their turn, and entering the plant tissues produce in and upon them the second or rust condition of the fungus, known as the *Roestelia* stage. The rust first shows itself as an orange or yellow spot on the upper side of a leaf for instance, in which cavities are formed producing certain bodies (*spermatia*) of unknown function, while subsequently after a period of time varying in different species from ten days to three or even four months the Roestelia appears in the form of tooth-like projections from the under side of the same spot. These projections contain great quantities of spores which are discharged into the air, and blowing back to the cedars and germinating upon them enter their tissues and give rise to new cedar apples which again reproduce the rust and so on.

The object of the present bulletin is to call attention to experiments which have been carried on at this Station in regard to the relations of the different species of cedar apples to the various forms of rust or Roestelia which they produce, and more especially to the development of the so-called "bird's nest" Gymnosporangium, the characteristic distortions of which are so familiar as to need no further description. Although so common a species, the experiments and observations of the writer have demonstrated that it has been hitherto undescribed, owing to various confusions which need not here be dwelt upon, and the appropriate name *nidus-avis* (bird's nest) is here proposed to distinguish this characteristic and strictly American form. The interest in the subjoined account is therefore rather scientific than economic, except in so far as it enforces the already well-known fact that to avoid certain rusts which are often serious on apple, quince or pear trees as well as on hawthorn used for ornamental or other purposes and several related plants, it is necessary to cut down adjacent cedars as far as is practicable; for although it has been shown that infection from cedars may take place at a distance of eight miles, the virulence of the disease is of course proportionate to the proximity of the cedars.

We have in Connecticut, so far as is now known, seven distinct species of Gymnosporangium: two upon the white or swamp cedar (*Cupressus thyoides*), neither of which are economically important, one peculiar to the common juniper (*Juniperus communis*), three upon the red cedar (*J. Virginiana*), and one occurring on both the last named plants; the last five species all possessing more or less economic interest, from the rusts which they are likely to produce. The writer has continued experiments on all these species for the past five years, and has succeeded by artificial cultures under test conditions in connecting all but one of them (*Gymnosporangium Ellisii*) with its proper rust, making at the same time a critical study and comparison of the different forms and stages. In a paper on the subject published in the Botanical Gazette (vol. xiv, No. 7) attention was called (p. 169 and 172, note) to the fact that the so-called bird's nest Gymnosporangium of the red cedar, which had hitherto been confused with another American (*G. clavipes*) as well as with a European species (*G. conicum*), was shown by cultures made at this Station and at Cambridge as well as by observations made in the vicinity of New Haven, to be a distinct and peculiarly American form as above

stated. The writer therefore feels justified in publishing the present preliminary note in order to ensure for the Station as well as his own studies and observations whatever credit may pertain to the solution of a problem in mycology which has offered considerable difficulties and demanded much careful thought and work.

In regard to the remaining species of Gymnosporangium it may be mentioned in passing that the experiments performed by the writer before he became connected with this Station have been repeated here in the case of *G. macropus*, *G. globosum*, *G. biseptatum* and *G. clavariaeforme*, the failure of cultures with *G. Ellisii* on the two occasions when they were attempted, having been directly traceable to the use of teleutospores which were not in good condition for cultures, the species not being readily obtainable in a fresh state. In the case of *G. macropus*, *G. clavariaeforme* and *G. biseptatum* results were obtained identical with those previously published by the writer, while in the case of *G. globosum* certain additional facts were ascertained ; namely, that perhaps the most common orange rust of apples in this state is undoubtedly caused by this species. This rust, which has been referred to in previous papers as "*lacerata z*," was induced by inoculation with sporidia from *G. globosum* on three seedling russets, the inoculation being made in the greenhouse by forcing the cedar apple as well as its host so early in the spring that all possibility of accidental mixture was avoided. Spermogonia appeared the first week in April, the infection having been made late in March, and perfect and typical aecidia were developed early in July. In addition to the cultures of *G. globosum* which were made on these apples, two plants of the mountain ash (*Pyrus Americana*) were inoculated with the same Gymnosporangium in April, and having produced luxuriant spermogonia gave abundant and well developed aecidia late in July. It may be mentioned in passing that these aecidia were *not* the *Roestelia cornuta* which occurs on the same host further north, but had all the characters of the Roestelia which follows inoculation by *G. globosum* on other hosts. In addition to the above facts it was ascertained that a rust of quinces and of Keiffer pears was referable to the same source both hitherto unrecorded hosts for this species. Cultures of *G. globosum* on Hawthorn (*Crataegus crus-galli*) were also repeated and produced abundant and well developed aecidia under equally strict conditions, confirming the writer's previous statements in all respects.

Returning to the "bird's nest" Gymnosporangium, infections with this species have been made by the writer every year since the spring of 1886, in order to determine definitely the true character of the rust which it produced, and the results in all the cultures were identical, as to the mode and rapidity of development and gross as well as microscopic characters. Until 1889, however, this rust had never been recognized in nature; but as soon as search was made for it in the light of the results artificially obtained, it was found in abundance near the Station and elsewhere in the State growing on Quince, but most luxuriantly on the Service berry (*Amelanchier Canadensis.*) Owing to its rapid development, the Roestelia matures by the first of June, simultaneously with the Roestelia of the juniper Gymnosporangium (*G. clavariæforme*), and since the two rusts inhabit both the above-mentioned host plants, they often occur together side by side on the same leaf, shoot or berry. For this reason although the two are quite distinct in gross appearance when closely examined, as well as in microscopic characters, they have never hitherto been distinguished and will doubtless be frequently met with in herbaria under *Roestelia "lacerata"* or the equally erroneous name *R. penicillata.* The general habit of the two is much the same, the *Roestelia nidus-avis* being, however, slightly less lacerate than *R. lacerata* and much darker owing to the rich rust brown color of its spores which contrasts strongly with the much paler dead brown of the spores of *R. lacerata* when seen *en masse.* Microscopically the two are separated at a glance, the spores of *R. nidus-avis* being smooth while those of *R. lacerata* are verruculose.

The *Gymnosporangium nidus-avis* it may be mentioned by no means confines itself to bird's nest distortions, but may occur in isolated areas on the smaller branches on which it produces a slight swelling like *G. clavipes*, or may attack the larger branches and even, not uncommonly, the main trunk of the tree in which its perennial mycelium has survived for years as a result of infection when the tree was very small, causing a conspicuous swelling of a part or the whole of the trunk, the bark of which in the diseased area is usually very rough. That these forms are not due to any species other than the *nidus-avis* has been shown by cultures.

The new species may be characterized as follows:

Gymnosporangium nidus-avis, nov. sp.

Sporiferous masses when young, cushion like, irregularly globose or oval, small and distinct or elongate and confluent according to the habitat; rich red brown; when mature indefinitely expanded by moisture, orange-colored. Teleutospores two-celled, irregular in shape broadly ovate to sub-elliptical or fusiform, bluntly rounded or slightly tapering towards the apex, symmetrical or often slightly bent. Average dimensions .055 × .025^{mm}. Promycelia several, not uncommonly proceeding from either extremity. Pedicels when young often more or less inflated below the spore. Mycelium perennial in leaves, branches or trunks of *Juniperus Virginiana* very commonly inducing a "bird's nest" distortion.

Roestelia stage. Spermogonia yellowish orange, preceding the aecidia by about ten days. Aecidia hypophyllous or more commonly on petioles, young shoots and especially on young fruit, densely clustered, brown, at first subulate, then fimbriate; the peridia splitting to the base with its divisions slightly divergent. Peridial cells rather slender; the ridges somewhat prominent, sub-labyrinthiform, horizontal or becoming inwardly oblique towards the extremities. Average measurements (towards the apex of the peridia) .07 × .018^{mm}. Aecidiospores smooth, spherical or irregularly oval to oblong, average diameter 25^{mm}.

Mycelium annual in the leaves of Cydonia (quince) and in leaves, stems and fruit of *Amelanchier Canadensis* (Service berry) in June.

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